

# Positive Pressure Ventilation: The Basics



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Critical Care Course

June 2009



# Goals

- Introduce the concept of positive pressure ventilation
- Introduce the most-commonly used ventilator modes
- Discuss patient case and appropriate mode selection
- Practice on the ventilators!



# Positive Pressure Ventilation

- Includes non-invasive ventilation...
  - e.g. facial mask with bagging, BiPAP or CPAP
- ...and invasive ventilation
  - e.g. via endotracheal tube or tracheostomy



# History of PPV

- 1555: Andreas Vesalius

*“...an opening must be attempted in the trunk of the trachea, into which a tube of reed or cane should be put; you will then blow into this, so that the lung may rise again...and the heart becomes strong...”*

- 1930-1950s: Polio Epidemic

- 1955 outbreak overwhelmed iron lungs

- 1950s: First PPV machine in Boston



# Negative Pressure = Normal

- Our normal breathing physiology
- Diaphragm contracts → negative intrathoracic pressure
- Air is sucked in → inspiration
- Blood is sucked in to return to the heart → increased venous return / increased preload



# Positive Pressure = Abnormal

- Air is pushed in by bag/machine → positive intrathoracic pressure
- Cardiovascular effects:
  - ↓ **preload**: blood can't get sucked in to heart
  - ↓ **afterload**/ ↑ cardiac contractility: pressure squeezes heart during systole
- Preload effect predominates if hypovolemic

# Moving on to the Ventilator...





# Ventilator Modes

## Volume-based Ventilatory Modes

- AC: Assist Control
- SIMV: Synchronized Intermittent Mandatory Ventilation

## Spontaneous Breathing Modes

- PS/PEEP
- CPAP





# Case 1 – 68 yo M COPD in ER

## ■ COPD “Triage” questions:

- History of intubation? Yes
- Home O2 use? Yes
- Oral steroid use? Yes

■ PE: RR 40, chest “clear”, falling asleep but can do 1 word answers when aroused

■ ABG: 7.25/90/<48/35 on 4L ncO2

■ What interventions, if any, will you do?



# Mode: Assist Control (AC)

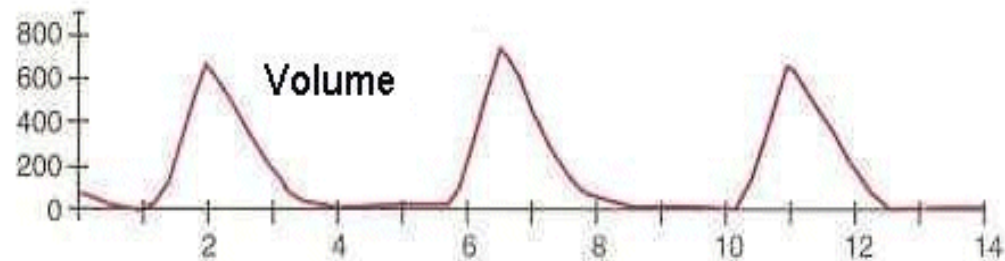
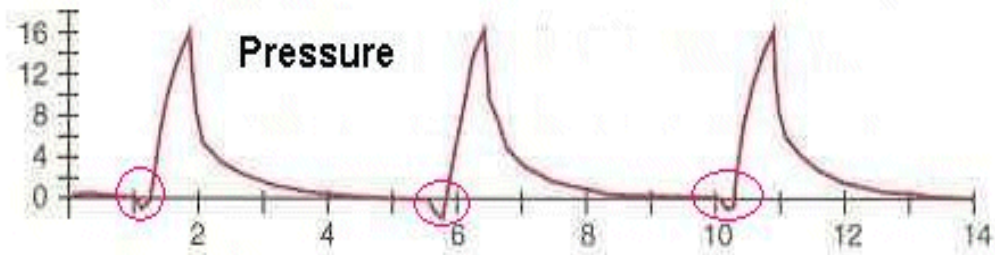
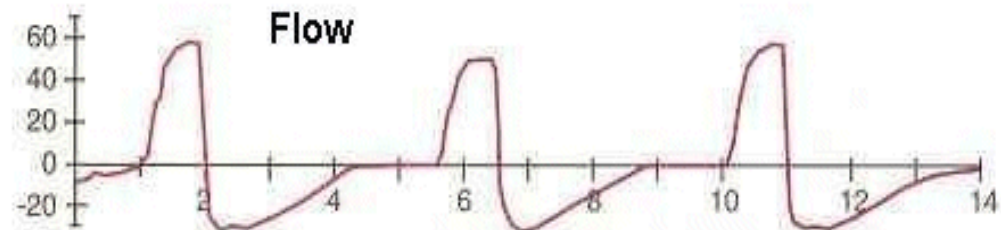
- Most common initial mode in our ICU
- You must fill out vent order form with:
  - Mode
  - Tidal Volume (usually 10 ml/kg ideal body weight)
  - Resp Rate (usually 14-18)
  - FiO<sub>2</sub> (usually 100 % at first)
  - PEEP (positive end expiratory pressure, usually 5cm)
- Every breath receives the same tidal volume ( $V_t$ ) regardless of preset rate.
- Extra breaths get the same tidal volume



# PEEP

- Positive End-Expiratory Pressure
- Air stent: minimum pressure used to “stent” the airway to prevent alveolar collapse/atelectasis
- $PEEP = \underline{\hspace{1cm}}? \underline{\hspace{1cm}}$

# Assist Control





## Case 2 – 68 yo M HD#2

- Pt is still intubated and on AC mode
- $\text{FiO}_2 = 60\%$
- Starting to open eyes intermittently
- ABG: 7.55/28/65/30
- “Dr, he’s overbreathing the vent; his rate is 40. Do we sedate him more?”
- What interventions, if any, will you do?



# Mode: Synchronized Intermittent Mandatory Ventilation (SIMV)

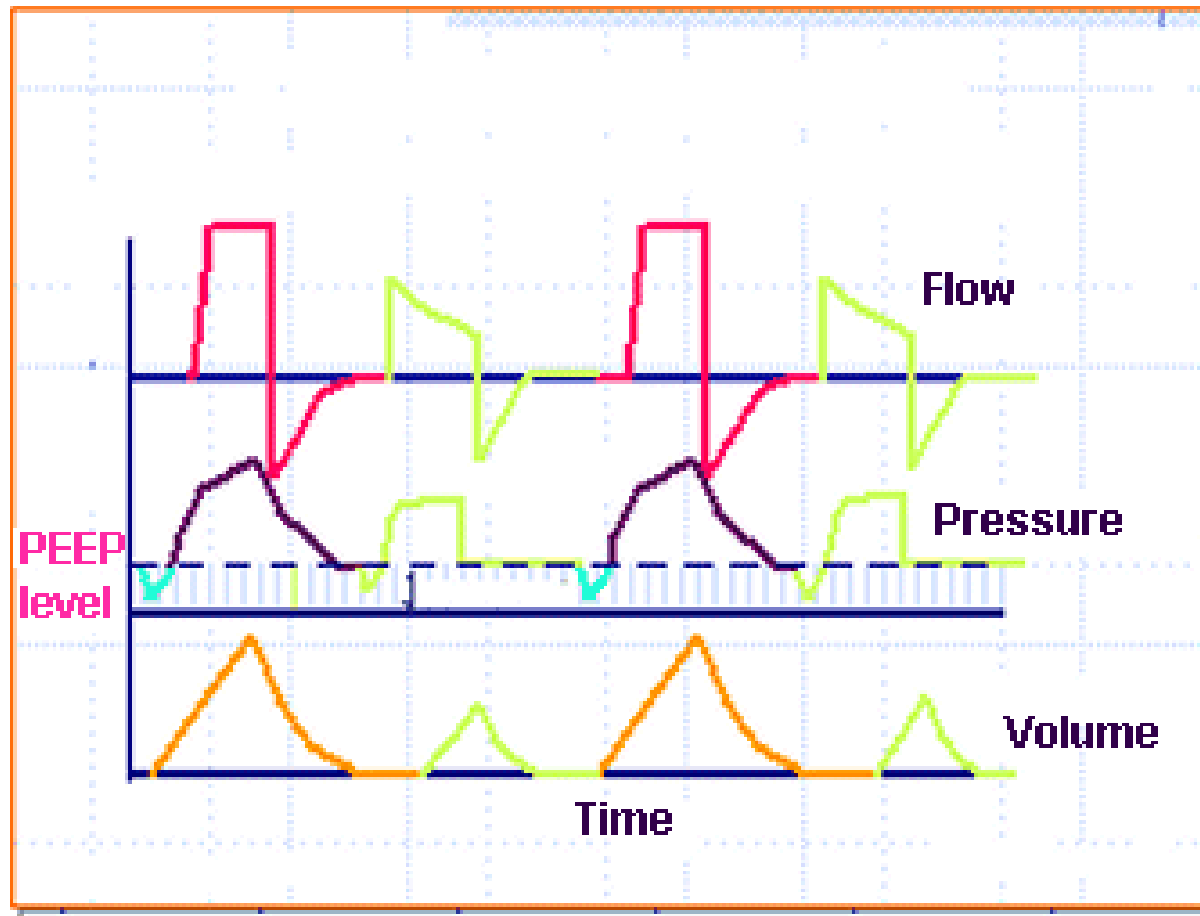
- You must order:
  - Mode, tidal volume, RR, FiO<sub>2</sub>, PEEP, and
  - Pressure Support (PS)
- Ventilator breaths receive full tidal volume only up to the set rate
- Extra patient breaths do not get the full tidal volume
- Extra breaths get PEEP +/- pressure support



# Pressure Support

- Only possible in IMV and spontaneous breathing modes
- The extra pressure above the PEEP used to provide additional inspiratory support
- Can vary from 0-25 cm

# SIMV



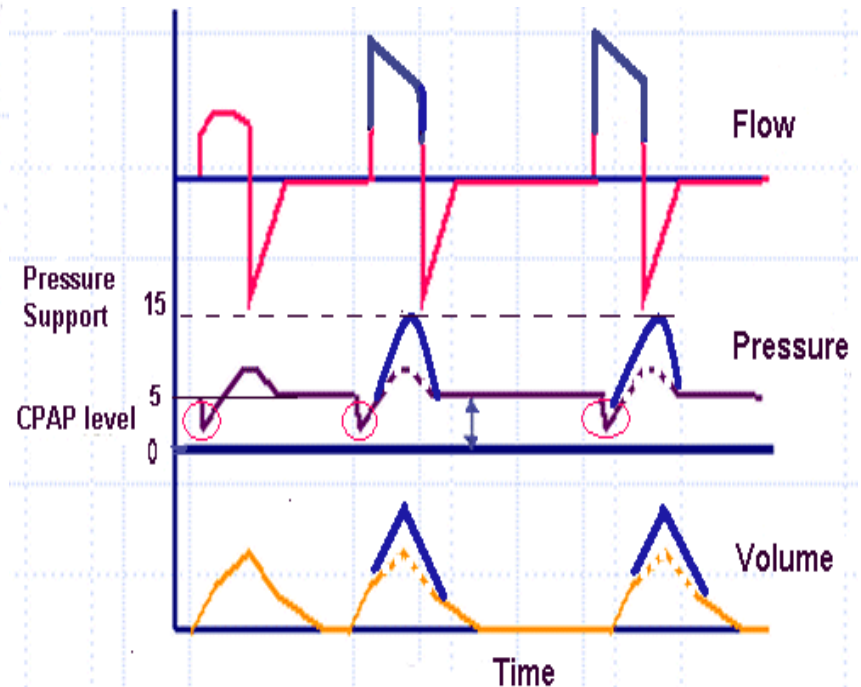
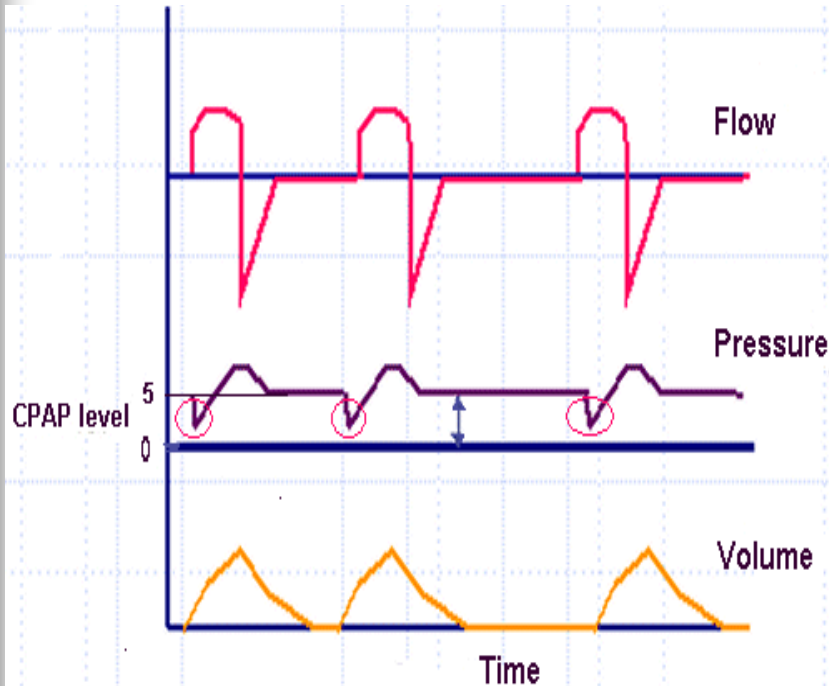




## Case 3 – 68 yo M HD#5

- Patient is still on SIMV
- He is alert on his daily awakening trial
- Follows commands
- RR is 25
- FiO<sub>2</sub> is 30%
- What interventions, in any, will you do?

# PEEP and PS/PEEP





And now...

... to the vents